Climate Change and Water Supply Security:
Managing Groundwater to Increase Drought Resilience

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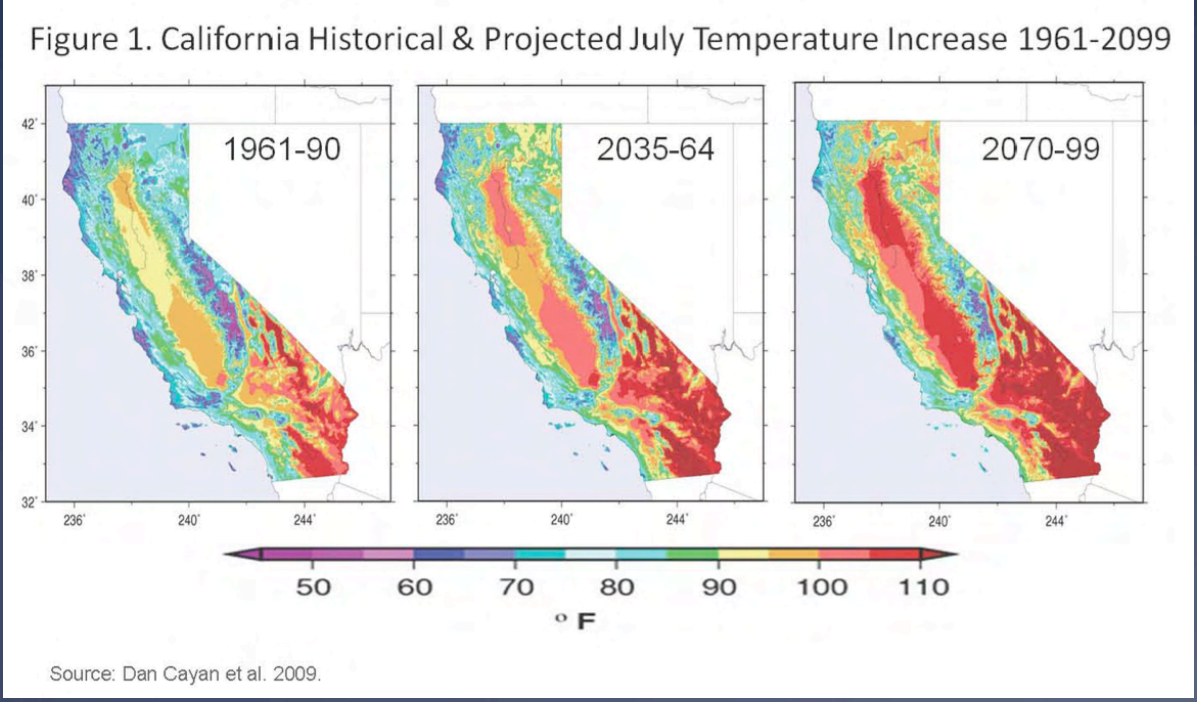
Climate Change

Higher temperatures
Diminished snowpack
Changes in extremes
Changes in surface run off
Rising sea levels

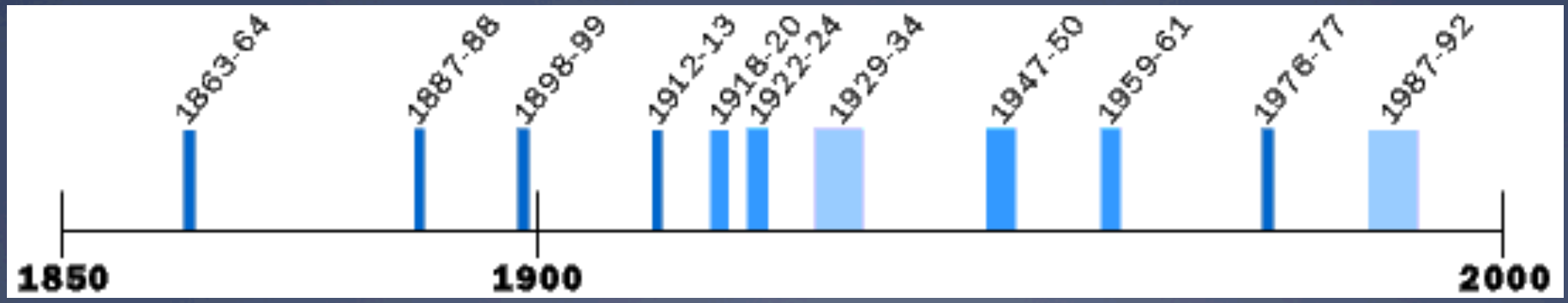


Less Freshwater Availability

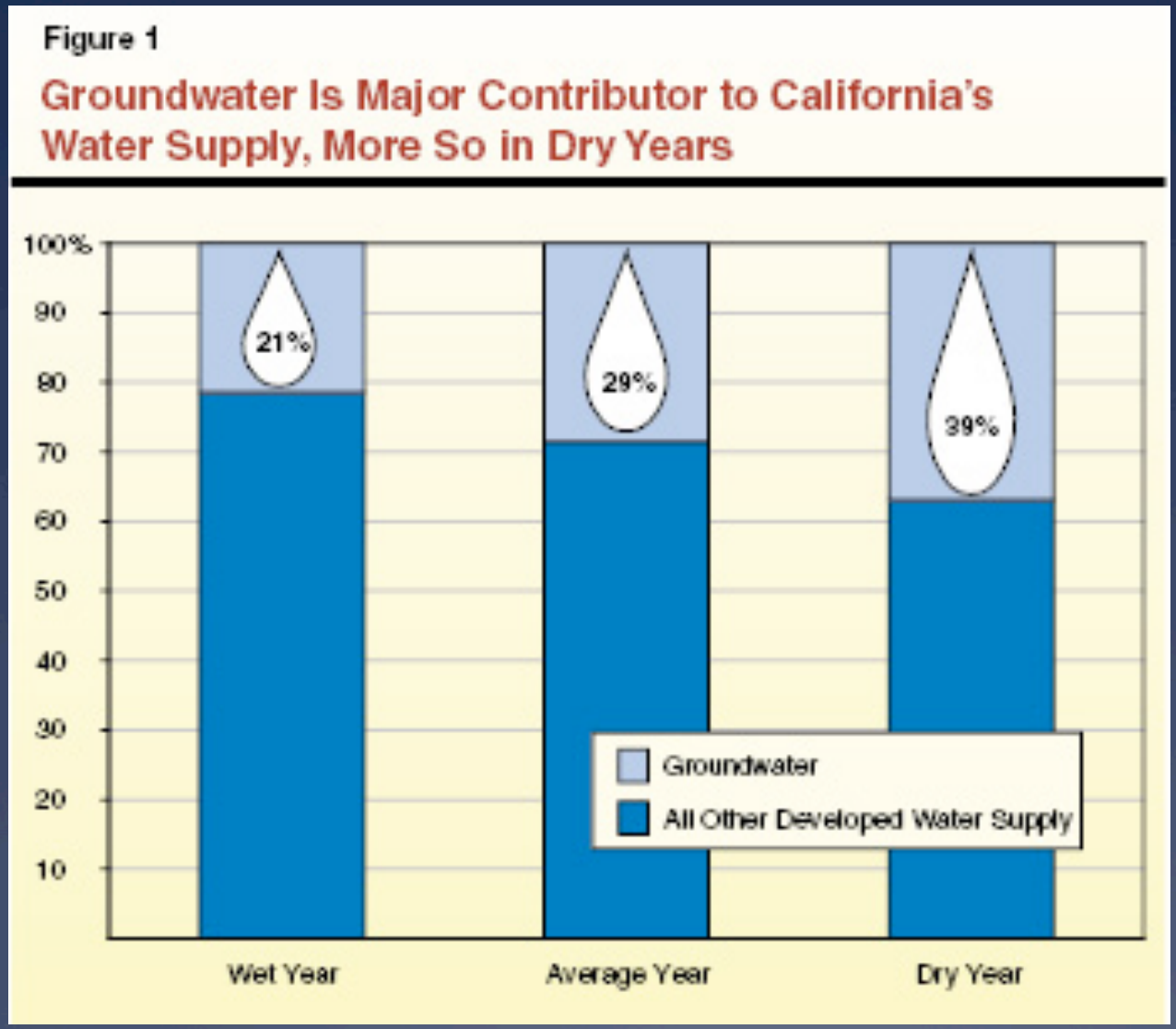
Drought

Less Freshwater Availability

California Droughts: 1850-2000



Groundwater pumping is likely to increase to compensate for reduced surface supplies



Legislative Analysts Office (2010)

Groundwater Overdraft

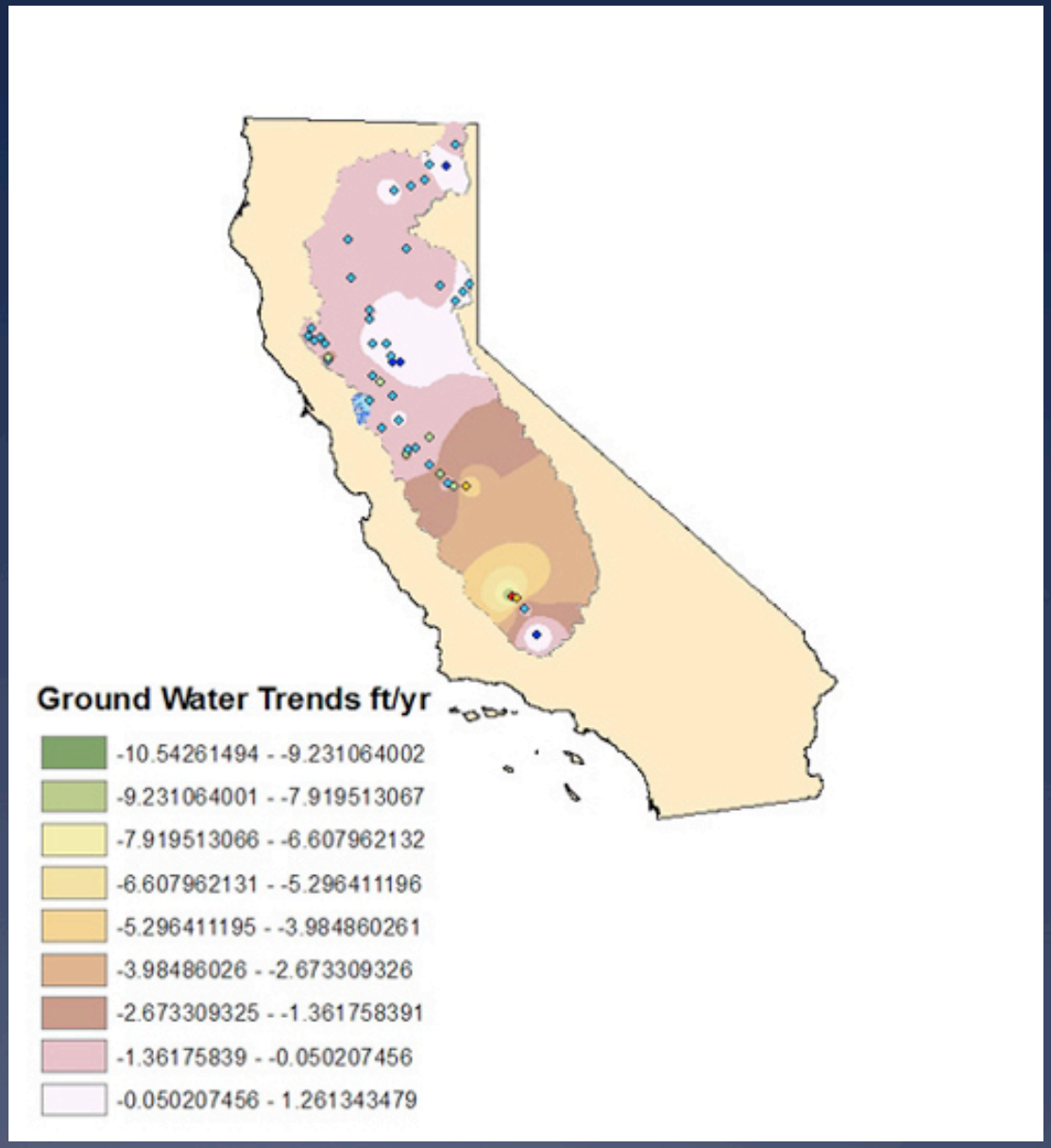
1980

11 basins - critical overdraft;
31 basins - evidence of overdraft;
5 basins - special problems

2013

Many of these basins show signs of continued depletion

DWR CA 2013



Groundwater storage changes in the Sacramento-San Joaquin River Basins from GRACE and supplementary data, October, 2003 to March, 2009

California's Typical Response to Droughts and Water Shortages

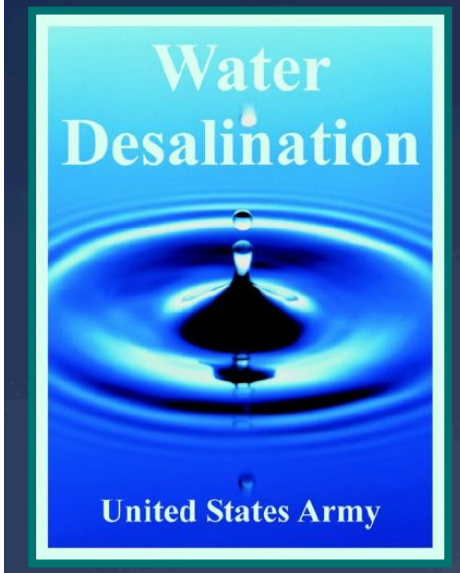
Pump More Groundwater
Water Curtailment After a Drought Occurs

"U.S. urges conservation as Colorado River hit by drought"

May 27, 2013 | Tony Perry, LA Times

And Develop Strategies to Generate More Supply

Desalination



Recycled Water

Conjunctive Management

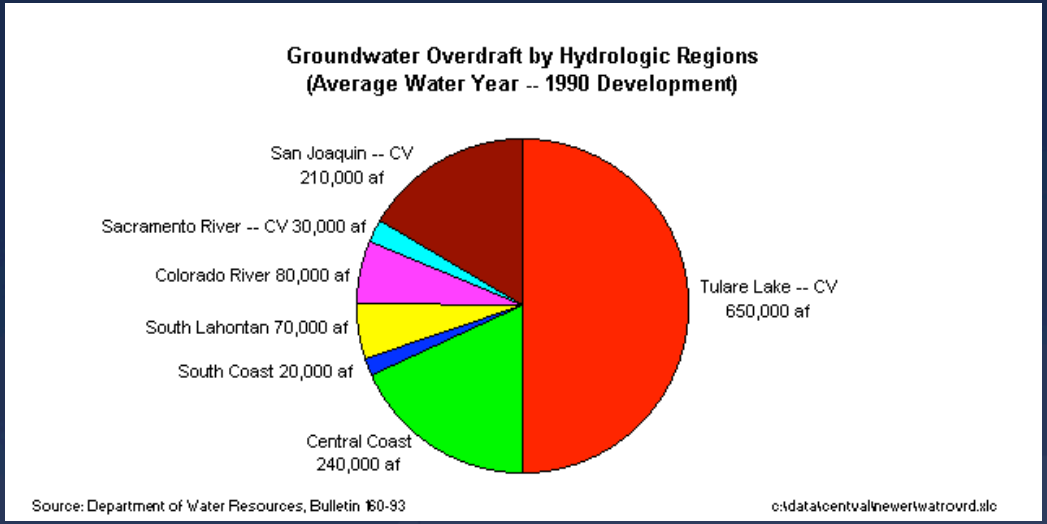
Caution!

Increase Water Supply During Dry Years

In Wet Years, Extra Water Can Lead
to More Development

No Reserve
and
Hardening of Demand Strategies

Increased Vulnerability in Future Droughts



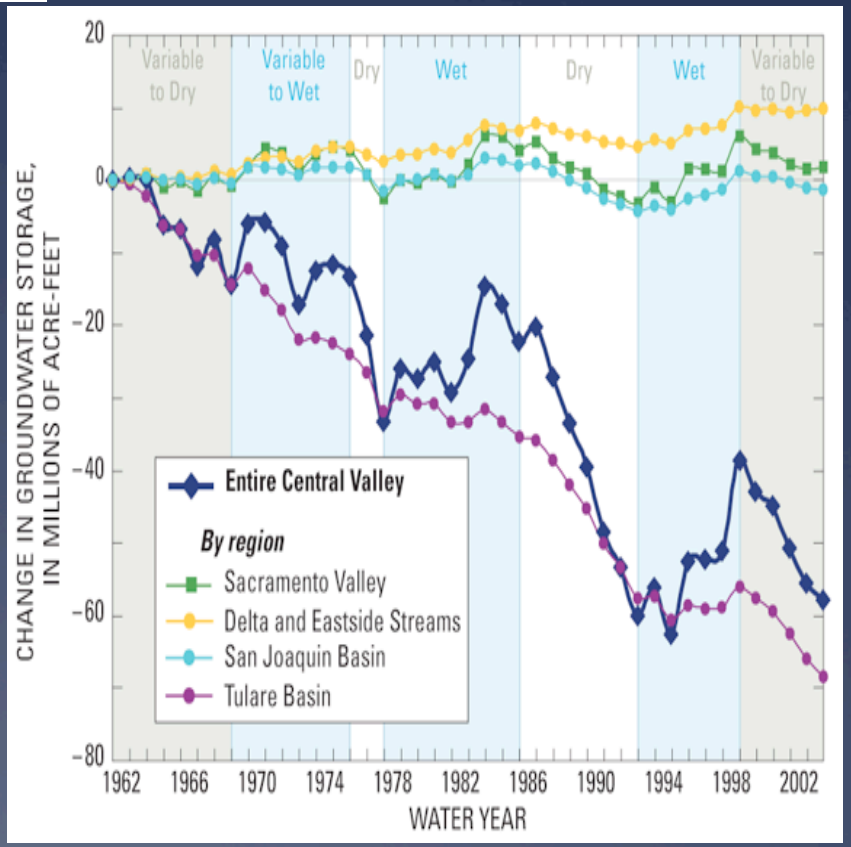
Groundwater Overdraft 1990

Change in GW Storage 1962 - 2002

Faunt et.al. 2009

Since ~1960, groundwater has been depleted by almost 60 million acre-feet

USGS 2009



How can California communities *proactively* adapt to droughts under climate change?

Local Groundwater Drought Reserves

Serve as a buffer during an extreme drought

Reduce overdraft impacts

Less energy intensive

Support groundwater dependent ecosystems

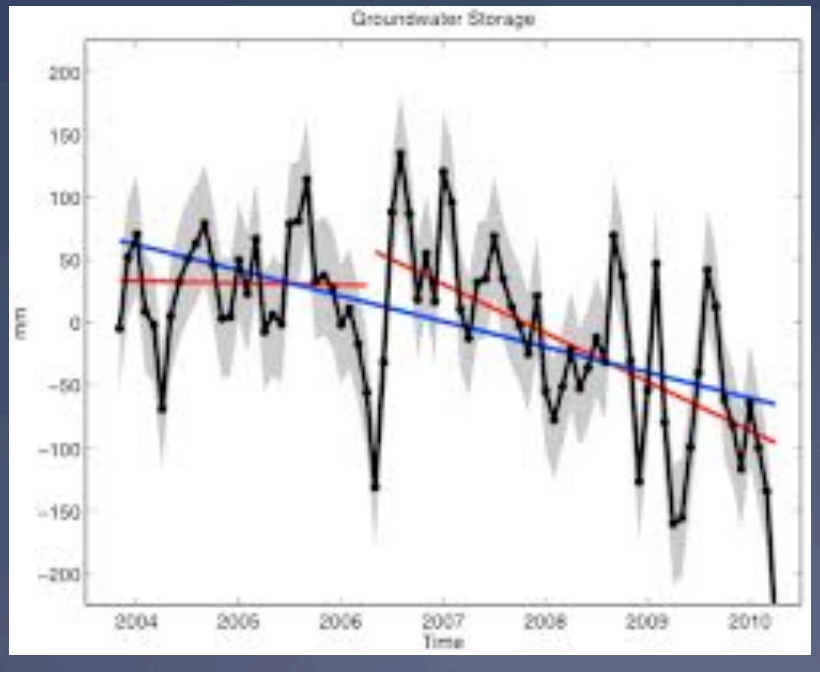
"..it never failed that during the dry years the people forgot about the rich years, and during the wet years they lost all memory of the dry years. It was always that way.

John Steinbeck

How does our approach differ from current groundwater banking?

Reserves are ***Sourced*** **–** ***Sited*** **–** ***Used*** Locally

Goal is to recover groundwater levels to avoid further declines during a drought



Central Valley-Groundwater Storage Trends
10/04 - 10/09
J. S. Famiglietti et. al. (2010)

Our Research

General and site-specific factors that affect drought resilience

Case Studies

Factors that motivate regions with conflicts over water to reduce long-term overdraft and proactively address drought

Impacts and financial costs of a groundwater drought reserve versus a no-reserve option

Tools to assist regions in determining thresholds and other parameters for a local groundwater drought reserve

Physical Context

Sources of water
Condition of groundwater basin

Legal-Institutional Context

Water Rights, Governance

Socio-Political Context

Stakeholder conflicts
Agency/Board leadership

Legal-Institutional Context

State

No Permit System for Percolating Groundwater

Overlying Landowners

Correlative Rights Doctrine

Local Agencies

Primary Managers of Groundwater

Agencies - City & County Ordinances - Adjudicated Basins

Federal

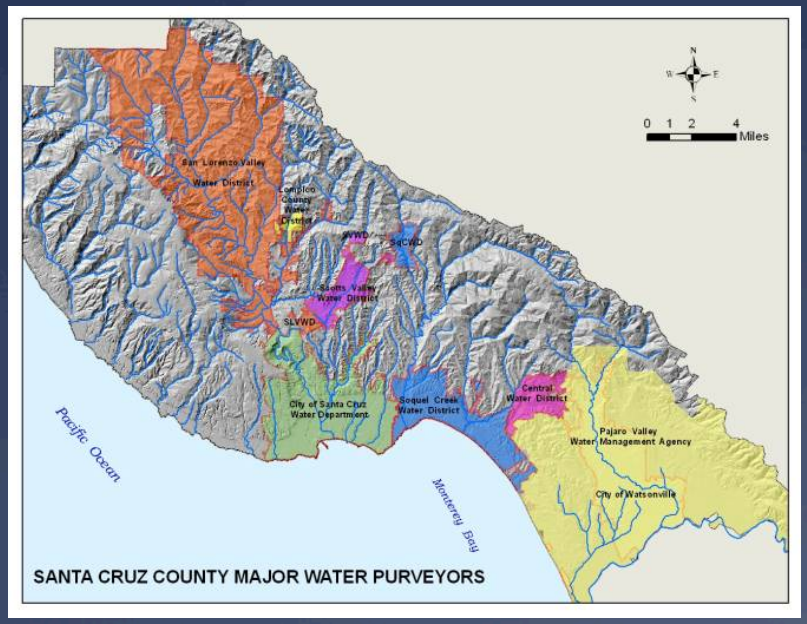
Endangered Species Act

What motivates local management to reduce overdraft and build resilience to water shortages?

Central Coast

Scotts Valley Water District

Pajaro Valley Water Management Agency



Santa Cruz Water Department

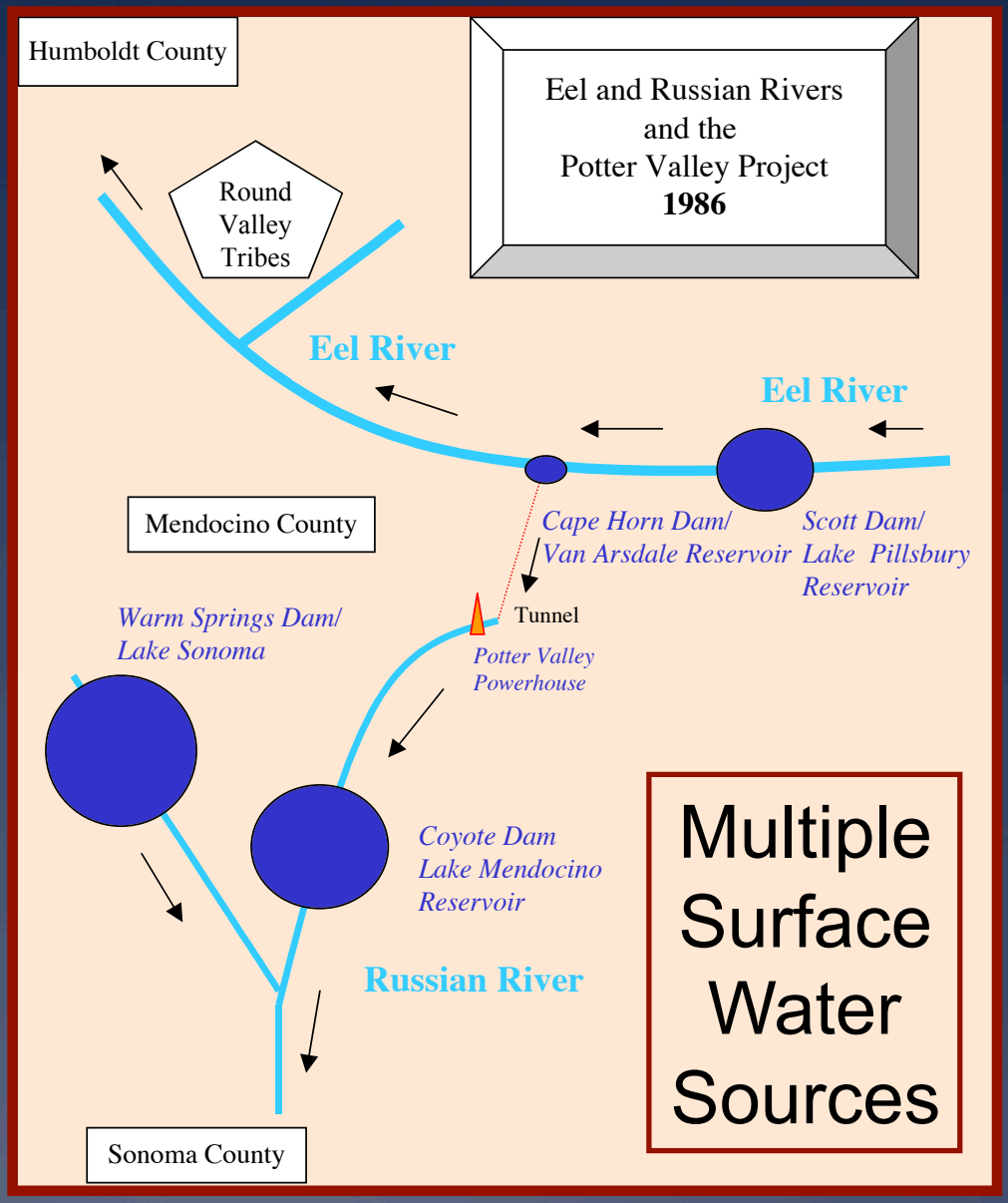
Soquel Creek Water District

North Coast

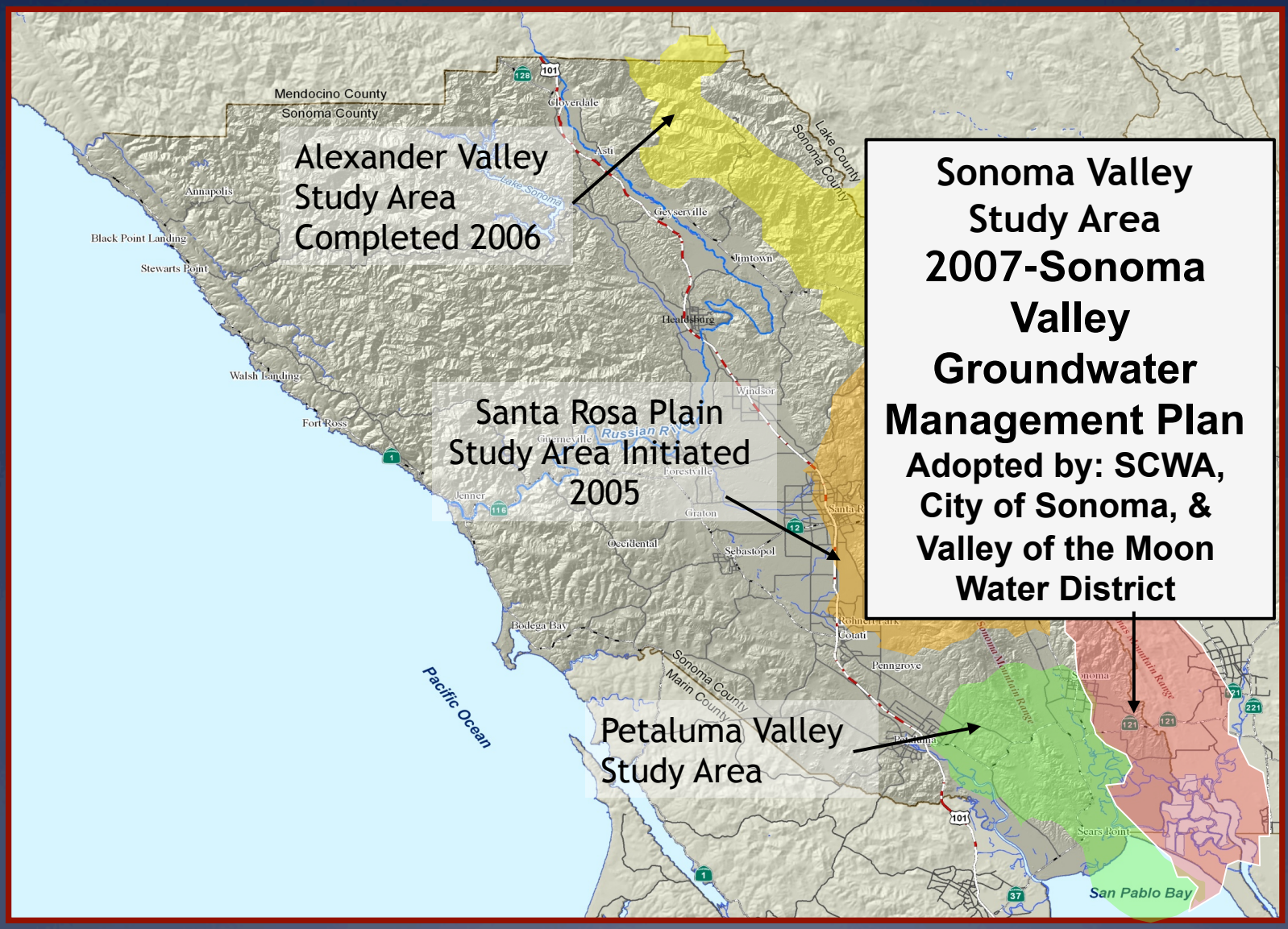
Sonoma County Water Agency

Sonoma County Water Agency

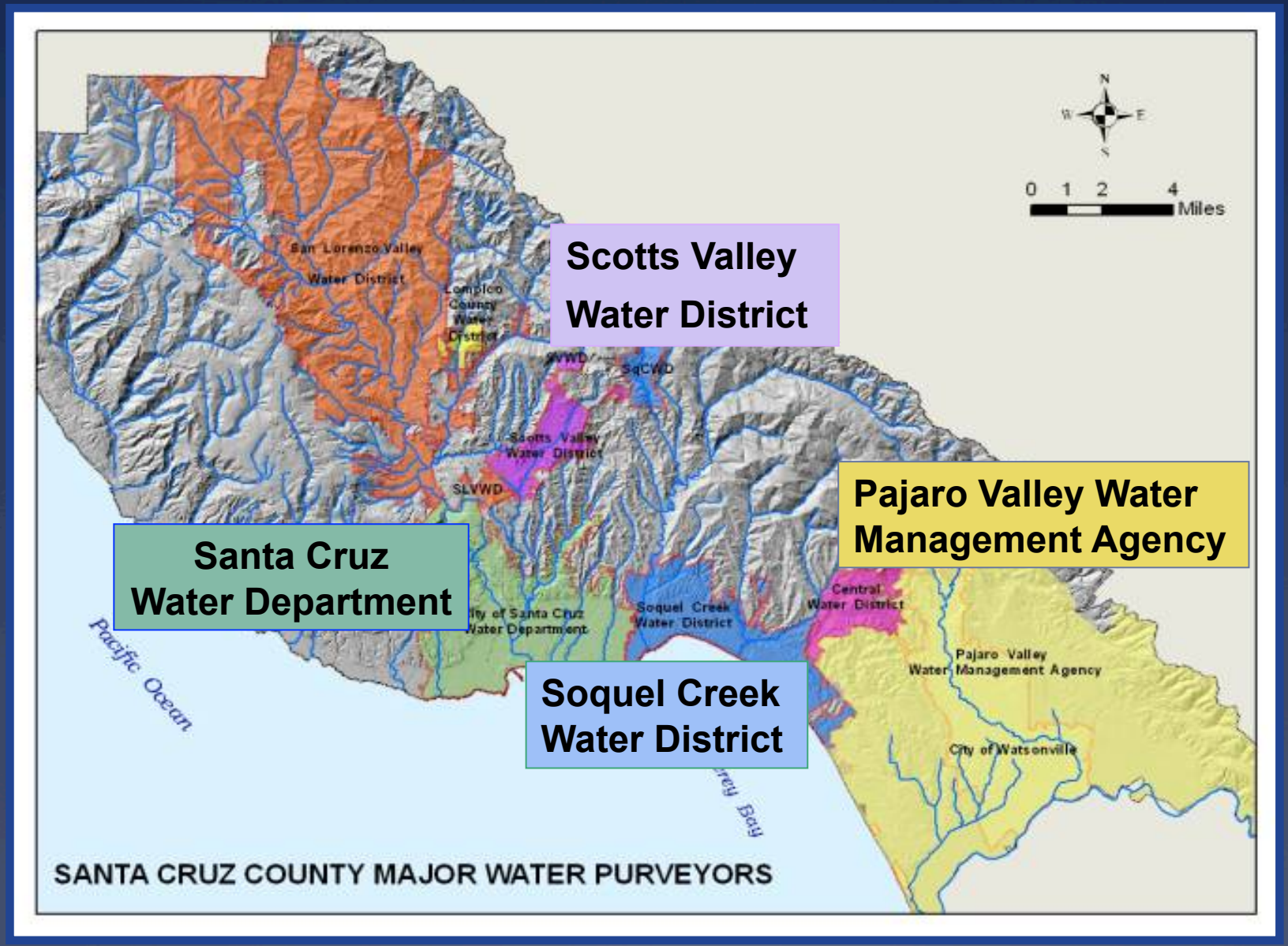
Russian River Endangered Species



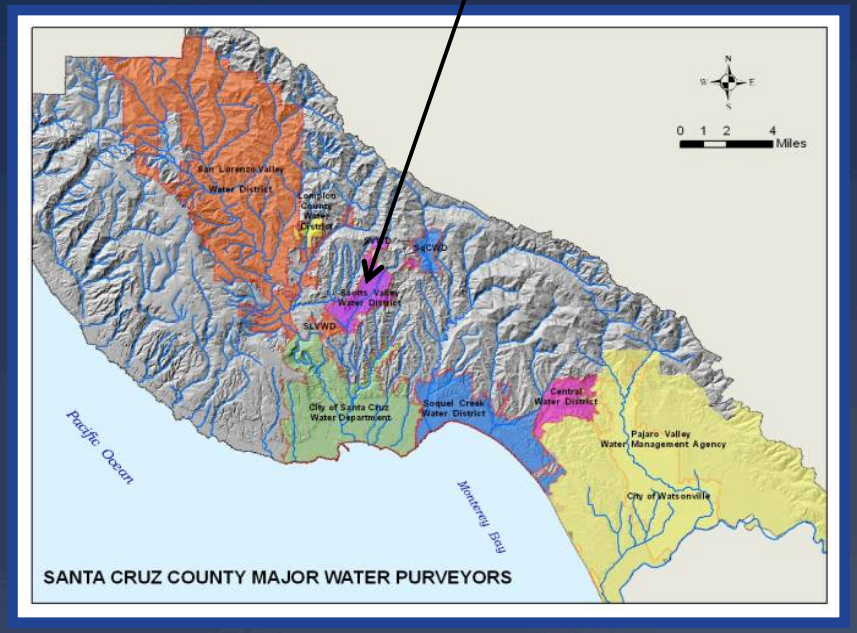
SCWA Groundwater Basins



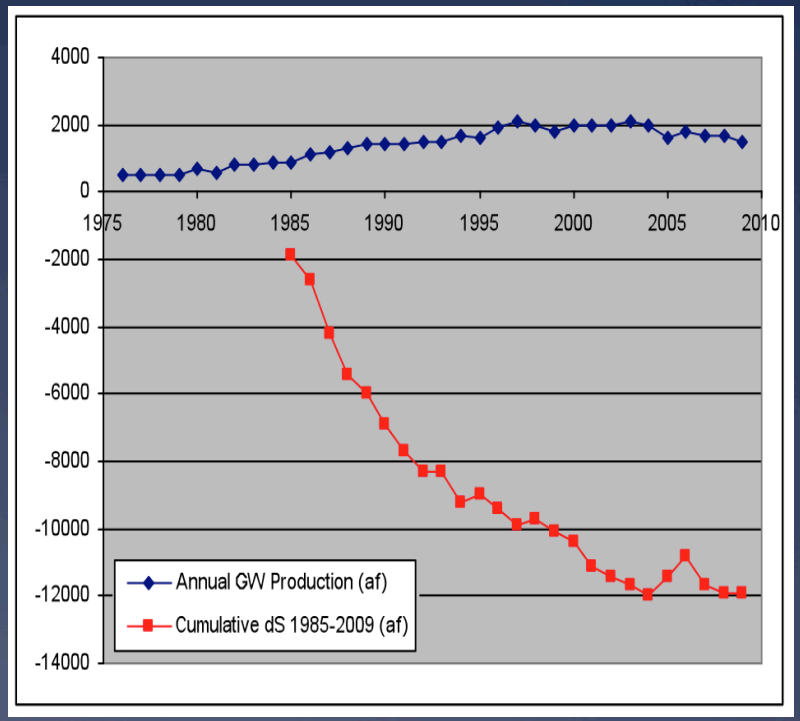
Central Coast Study Areas



Scotts Valley Water District



The Santa Margarita Groundwater Basin Is sole source of potable water for SVWD



Strategies to Reduce GW Production

Water Conservation

Recycled Water

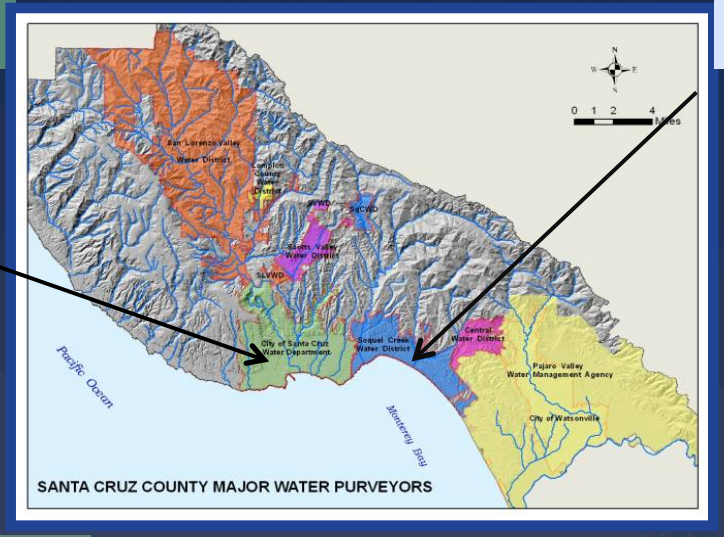
Gray Water

Rebates

1975-2010 : Change in GW Production & Storage

Santa Cruz Water Department

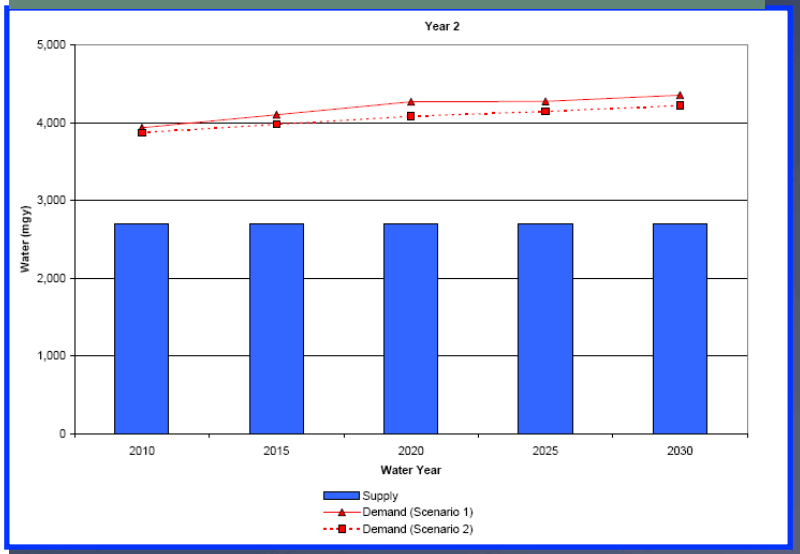
Surface Water Dependent



Soquel Creek Water District

Groundwater Dependent

Multiple Dry Water Years Demand Exceeds Supply

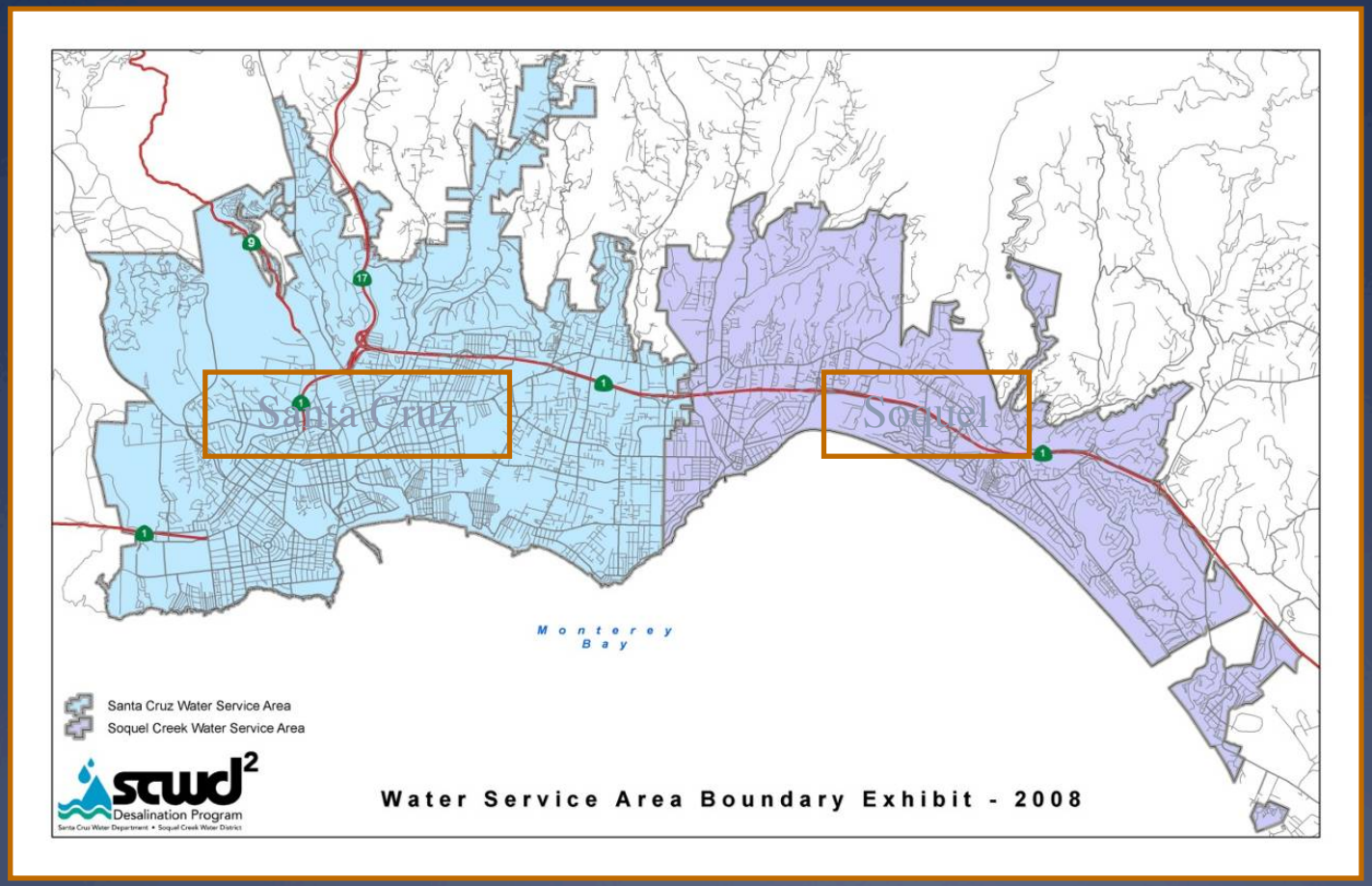


The Purisima and Aromas Red Sands Aquifers provide all of SqCWDs water

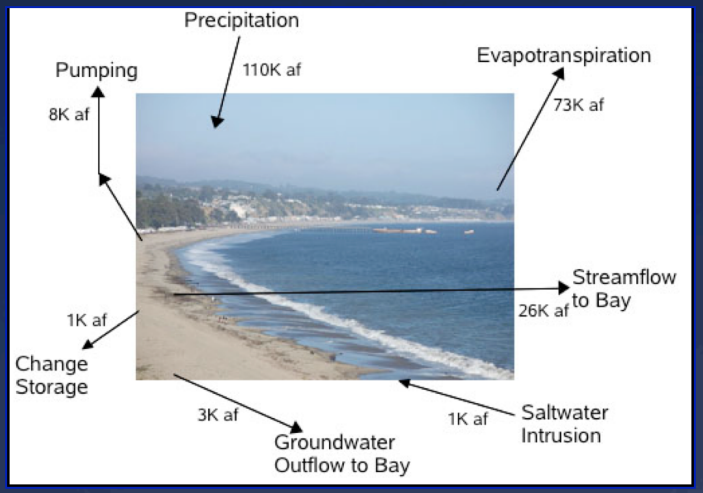
and are at risk for seawater intrusion

Drought Reserve Project

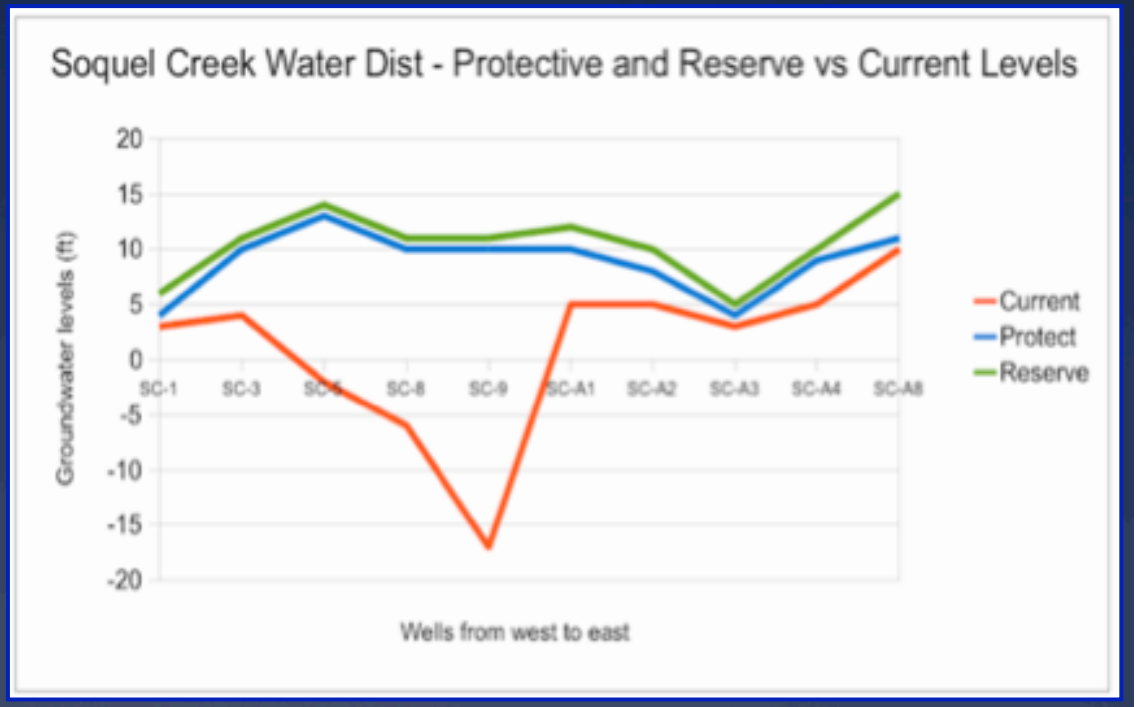
Collaboration Between
Santa Cruz Water Department
and Soquel Creek Water District



Calculating a Drought Reserve for Soquel Creek



Water Balance Model Soquel Creek
Daniels (2011) from: SqCWD. 2004 & 2009

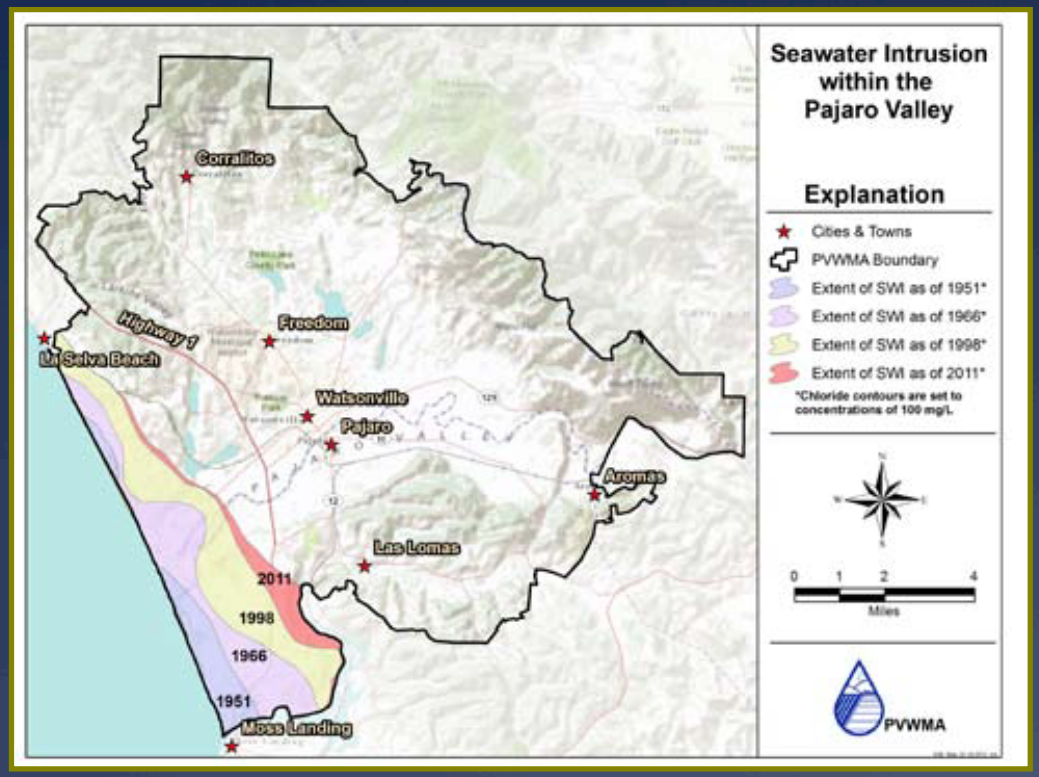


Source: Data from Soquel Creek Water District. 2009.
Groundwater level metrics can be converted into acre-feet

Current Project

Work with agencies to develop decision support tools for developing a drought reserve

Pajaro Valley Water Management Agency



Seawater Intrusion

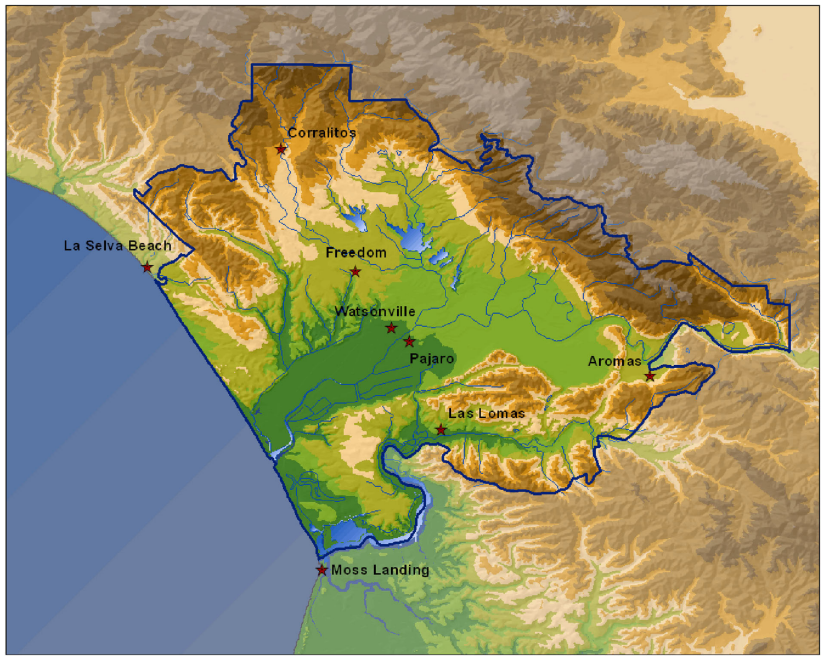
1998-2011 - 12% increase

Since 1951, ~ sevenfold increase

Largest increases during droughts

Recycled Water
Recharge Facilities
Coastal Distribution System

Stakeholder Conflicts & Litigation



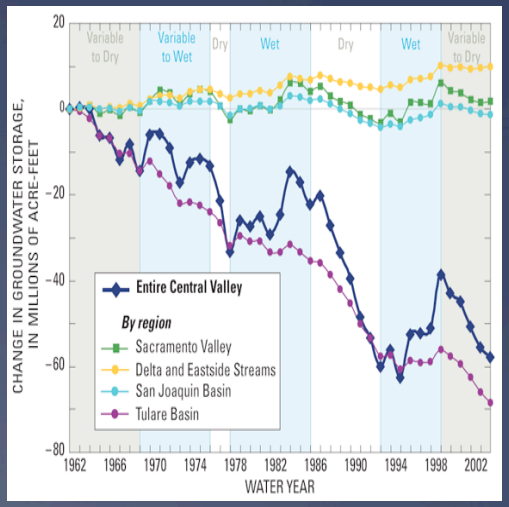
Current Project

Pajaro Valley In-Depth Case Study

Factors that motivate regions with conflicts over water to reduce long-term overdraft and proactively address drought

What Local Agencies Are Doing

Water Neutrality Program
Rebates for Conservation
Awards for Demand Reduction
Promotion of Recharge
Recycled Water
Cooperative Partnerships
Tiered Pricing



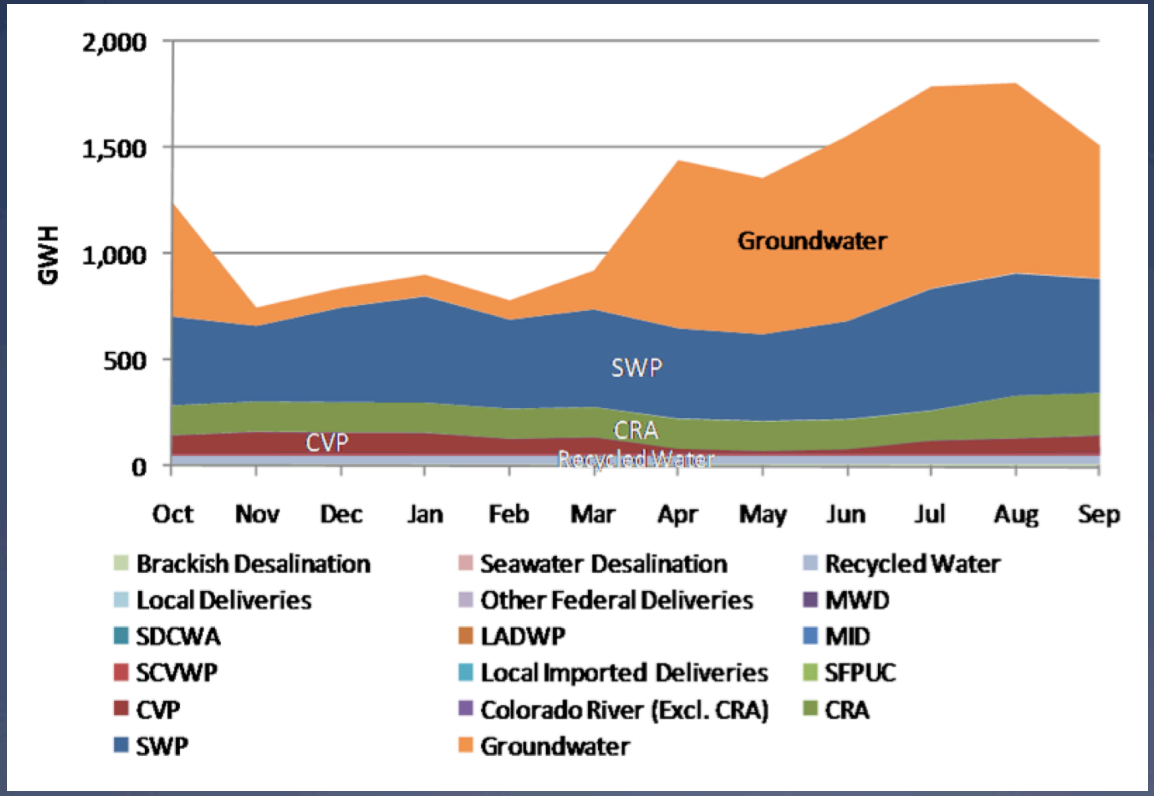
Incentives to increase storage

Current Project

Impacts & costs of a groundwater drought reserve versus a no-reserve option

Groundwater Pumping and Energy Use

Groundwater pumping accounts for more electricity use during summer months than pumping for the state's three largest water conveyance systems – SWP, CVP and CRA - combined



Research approaches to state-local ***cooperative*** structures that would identify and implement enforceable standards for groundwater withdrawals

Thank You

http://droughtreserves.ucsc.edu/

"The limiting factor is water — that is true of all civilizations."
Dana Bartholomew, Los Angeles Daily News